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ON THE DESTRUCTIVE NATURE OF THE BORING SPONGE, WITH OBSERVATIONS ON ITS GEMMULES OR EGGS.

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IN 1871 a vessel laden with marble was sunk in Long Island sound, and according to Prof. Verrill, the boring sponge has penetrated the exposed parts of the blocks for a depth of two to three inches from the surface. The canals or tunnels in a specimen of this marble which I have examined, vary from one-fourth to an hundredth of an inch and less in diameter; the canals are coated within with a thin film of dried sarcode of a brown color, which was orange-colored in life. Though the sarcode is dried, the needle-shaped spicules are plainly visible under a one-fifth inch lens, and display the form usually seen in the same species found on the coasts of Europe. The spicules, according to my measurements are $\frac{1}{83}$ of an inch long, agreeing exactly with the length given by Mr. H. J. Carter as observed in British specimens, and about $\frac{1}{10000}$ of an inch in diameter, and are, as is well known, siliceous. The specimen which I have seen, shows, in what appears to have been the inner portion of the block, a series of large branching canals which connect freely with each other in the most irregular way imaginable; moreover, the form of the canals in transverse section is exceedingly variable, being oval or irregular as often as it is circular. These last facts, together with that of the great variability in the calibre of the canals, leaves no doubt in my mind that it is the animal of the sponge which does the boring, and not marine worms which have politely abandoned their bur-

rows for the accommodation of this toiler of the sea. It is well known that this species and its allies are found filling systems of canals in the shells of many species of mollusks, both dead and alive, as well as in fragments of limestone, but it is probably rare to find it in such a vigorous condition of development as in the submerged cargo of marble referred to above. Mr. H. J. Carter believes that occasionally some of the parasitic species do not bore their habitation but develop freely in the same manner as ordinary non-parasitic forms. Bowerbank in his "Monograph of the British Spongidæ," mentions an affiliated species which is parasitic on a sea-weed, boring or dissolving away the soft parts and allowing the harder fibrous structures to remain as a means of support.

It may be well to bear in mind that these sponges, notwithstanding the fact that they excavate their own habitations, are not parasites in the sense in which nematoid and cestoid worms are parasitic, as Haeckel, with his usual sagacity, points out in his Monograph of the Calcareous Sponges.

Dr. O. Schmidt observes (Brehm's Thierleben), that, "A large portion of the coasts of the Mediterranean and Adriatic seas is composed of calcareous material which, from its tendency to become eroded, has a broken, jagged aspect, giving it a peculiar and often attractive appearance. Of such broken Dalmatian coast one can certainly measure off some thousands of miles of strand, and where it does not descend too abruptly, large and small stones and fragments of rocks cover the ground. One can scarcely pick up one of these billions of stones without finding it more or less perforated with holes and eroded by Cliona, often to such a degree that the spongy remains of the apparently solid stone may be crushed in the hand." The same writer farther observes: "This brings us finally to the question, by what means does this sponge eat its way into the rock? One would first think of the siliceous needles as the cause, but we soon see that we must abandon the notion that this is the boring apparatus, since it must be borne in mind that such apparatus must be operated. Even though the protoplasm executes delicate fluctuating movements, so that in *Cliona* (*Vioa*), as in many other sponges, the needles are drawn into bundles, rows or series in particular directions, in any case, the force so exerted would not be sufficient to scrape or erode the lime rock with their

points. The mode of distribution and extension of the sponge would rather indicate that a process of chemical solution was the real agent at work in erosion. Of the exact constitution of this corrosive fluid we, however, as yet know nothing. The importance of the boring sponge in helping to effect the redistribution of eternal matter, does not consist in comminuting the stone into particles, but in dissolving it as sugar is dissolved in a glass of water, and mingled with the sea-water in this dissolved condition. Out of this solution the innumerable shell-fish take the mineral materials which have been mingled with their blood, and from which it is deposited as new layers on the shell, which, when the animal dies, either is also finally redissolved by the sponge, or falls to the bottom of the sea as a contribution to the earth's strata of future æons."

Dr. Leidy[1] observes in regard to the agency of this organism in disintegrating the shells of dead mollusks, "that an extensive bed of oysters, which had been planted by Thos. Beasley at Great Egg harbor, and which was in excellent condition three years since (1857), had been subsequently destroyed by an accumulation of mud. The shells of the dead oysters, which were of large size and in great number, in the course of two years have been so completely riddled by the boring *Cliona*, that they may be crushed with the utmost ease, whereas without the agency of this sponge the dead shells might have remained in their soft muddy bed devoid of sand and pebbles, undecomposed perhaps even for a century." The ability of such an organism to comminute both organic and inorganic calcareous materials is well illustrated in the instance above cited, and their influence in modifying the character of marine deposits is clearly implied.

In a specimen of the common *Ostrea virginiana*, recently handed me for examination by my friend, Mr. John Ford, the substance of the shell was thoroughly cavernated so as to render it extremely brittle and readily crushed; in fact the inner table of the shell left standing showed a great number of elevations within, which indicated points where the intruding parasite had been kept out by the oyster which had deposited new layers of calcareous matter at these places so as to give rise to the elevations spoken of. Besides this, the inner table had become so weakened at the insertion of the adductor muscles that the animal

[1] Proc. Acad. Nat. Sciences, Phila., VIII, 162.

in closing had torn a part of it loose, which had been repaired by the deposition of a brown horny substance. Evidence of the presence of the boring sponge may very frequently be noticed in shells of oysters brought to the markets, though it often appears as if the parasite had left its work incomplete, being killed on its host. I find that Schmidt has also noted this, and that the boring operations of the sponge usually seem to stop in the case of living mollusks, at the nacreous layer.

Dr. Leidy (l. c.) gives a lucid account of the living sponge as found in *Ostrea virginiana* and *Venus mercenaria.* He says, "This boring sponge forms an extensive system of galleries between the outer and inner layers of the shells, protrudes through the perforations of the latter tubular processes, from one to two lines long, and one-half to three-fourths of a line wide. The tubes are of two kinds, the most numerous being cylindrical and expanded at the orifice in a corolla form, with their margin thin, translucent, entire, veined with more opaque lines, and with the throat bristling with siliceous spiculæ. The second kind of tubes are comparatively few, about as one is to thirty of the other, and are shorter, wider, not expanded at the orifice, and the throat unobstructed with spiculæ. Some of the second variety of tubes are constituted of a confluent pair, the throat of which bifurcates at bottom. Both kinds of the tubes are very slightly contractile, and under irritation may gradually assume the appearance of superficial wart-like eminences within the perforations of the shell occupied by the sponge. Water obtains access to the interior of the latter through the more numerous tubes, and is expelled in quite active currents from the wider tubes."

A point of considerable interest in this connection is Mr. W. J. Sollas'[1] discovery of the existence of membranous and spiculiferous diaphragms in some English species of these sponges. These diaphragms are composed of sarcode in which, in some instances, very short club-shaped spicules are imbedded, pretty densely packed together, with their opposite extremities lying at opposite surfaces of the diaphragm. In some cases the diaphragms are perforate, forming an annular band inside the canal and attached by an edge, the other edge being constricted somewhat, so that the bands sometimes have the form of hollow truncated cones. In other instances these partitions are membranous films contain-

[1] Am. Mag. Nat. Hist., 5th Series, Vol. 1, No. 1, 1878, p. 54.

ing spiculæ of the ordinary form; these also may be perforate or imperforate and conical. Their office is not yet understood, but it is suggested by their discoverer that they are for the purpose of interrupting or modifying the direction and flow of the currents of water created by the ciliated cells of the tissue lining the cavities of the organism.

In the examination of a second specimen kindly handed me by Mr. Ford, and which had been removed from its native brine only a few hours before, I was enabled to distinguish very plainly the ova or gemmules strewn through the orange-colored sarcode. These are bodies fully three times as large in diameter as the ordinary sponge cell, of an oval shape covered with a tough transparent rather thick membrane. The contents are transparent and granular with the exception of the nucleus, which is opaque and deep-orange in color and is often broken up into several apparently homogeneous granules of variable size; a part of these granules may occupy one extremity of the ovum, another part the other, or they may be placed eccentrically, or be arranged in a semicircle. The diversity in this respect is very great, so that but few are met with which are very nearly alike. These differences may represent various stages of development, but there seems to be a want of the orderly arrangement which would be expected if this were the case, besides, the wide separation of the nuclear bodies into two and even three parcels would not favor such a view.

I was quite unable to distinguish any flagellate cells in this specimen, even with a power of 1000 diameters, although there can be little doubt of their existence, as may be inferred from Prof. Leidy's account of the physiological actions of the organism. Mr. Carter, however, has figured these cells in a paper already referred to, and he observes that the flagelliform processes of the cells lining the canals of the fresh-water sponges are withdrawn into the sarcode body of the cell soon after being detached from the walls of the canals, which may have been the trouble in this case.